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Arai et al.

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(54) **IMAGE PROCESSING APPARATUS AND IMAGE PROCESSING METHOD ADAPTED TO CORRECT COLOR UNEVENNESS**

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(51) **Int. Cl.**
G06K 15/00 (2006.01)
H04N 1/405 (2006.01)
H04N 1/46 (2006.01)

(52) **U.S. Cl.** **358/3.06**; 358/3.2; 358/534; 358/536

(58) **Field of Classification Search** 358/3.06, 358/3.2, 3.23, 406, 504, 534, 536
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,457,541	A *	10/1995	Burns	358/3.21
2002/0186415	A1 *	12/2002	Condon et al.	358/3.06
2004/0012817	A1 *	1/2004	Brewington et al.	358/3.06
2005/0213123	A1 *	9/2005	Kobayashi	358/1.9

FOREIGN PATENT DOCUMENTS

JP	A 5-227396	9/1993
JP	A 6-3911	1/1994

* cited by examiner

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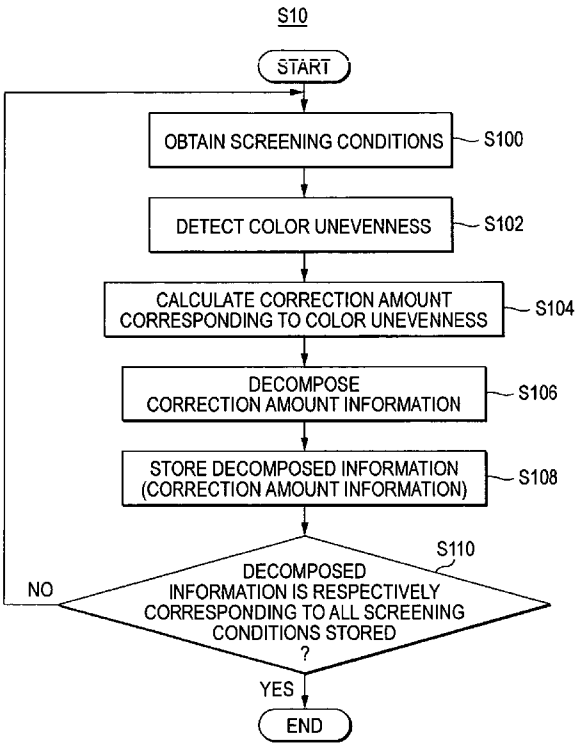
(57) **ABSTRACT**

An image processing apparatus includes a storage unit that stores a correction amount used to correct color unevenness of an image according to a plurality of halftone screening conditions; and a correction unit that corrects an input image according to the correction amount stored in the storage unit. The stored correction amount includes common information, which is common among the halftone screening conditions, and dependent information, which is dependent on the respective halftone screening conditions.

16 Claims, 8 Drawing Sheets



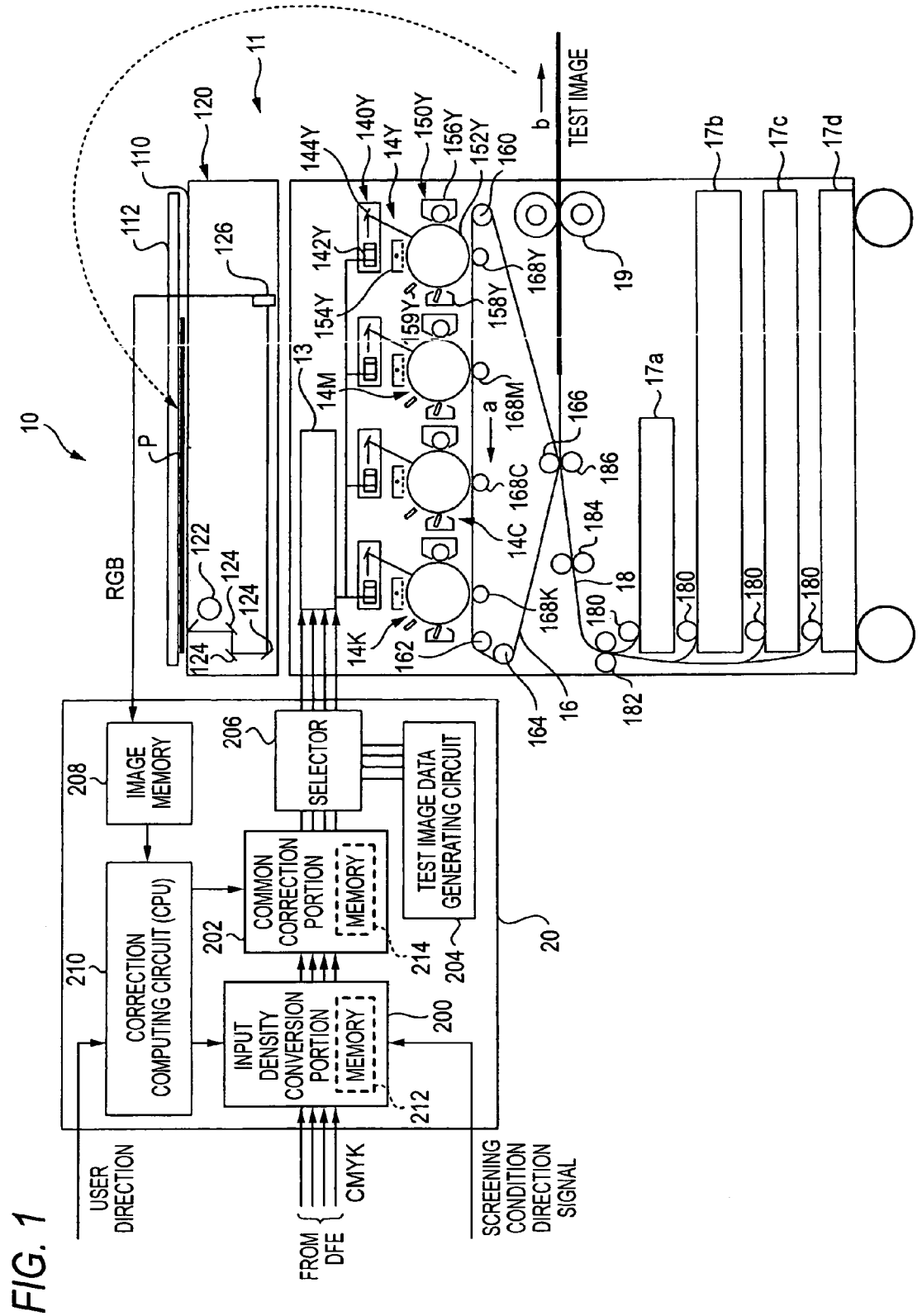

10
11
120
110
112
126
P
RGB
122
124
13
14M
14C
14K
14Y
144Y
140Y
142Y
154Y
159Y
150Y
156Y
152Y
160
158Y
168Y
168M
168C
168K
166
186
184
18
180
182
16
164
162
a
b
TEST IMAGE
19
17a
17b
17c
17d
20
IMAGE MEMORY
208
SELECTOR
206
TEST IMAGE DATA GENERATING CIRCUIT
204
COMMON CORRECTION PORTION
MEMORY
202
214
CORRECTION COMPUTING CIRCUIT (CPU)
210
INPUT DENSITY CONVERSION PORTION
MEMORY
200
212
USER DIRECTION
FROM DFE
CMYK
SCREENING CONDITION DIRECTION SIGNAL

FIG. 1

FIG. 2

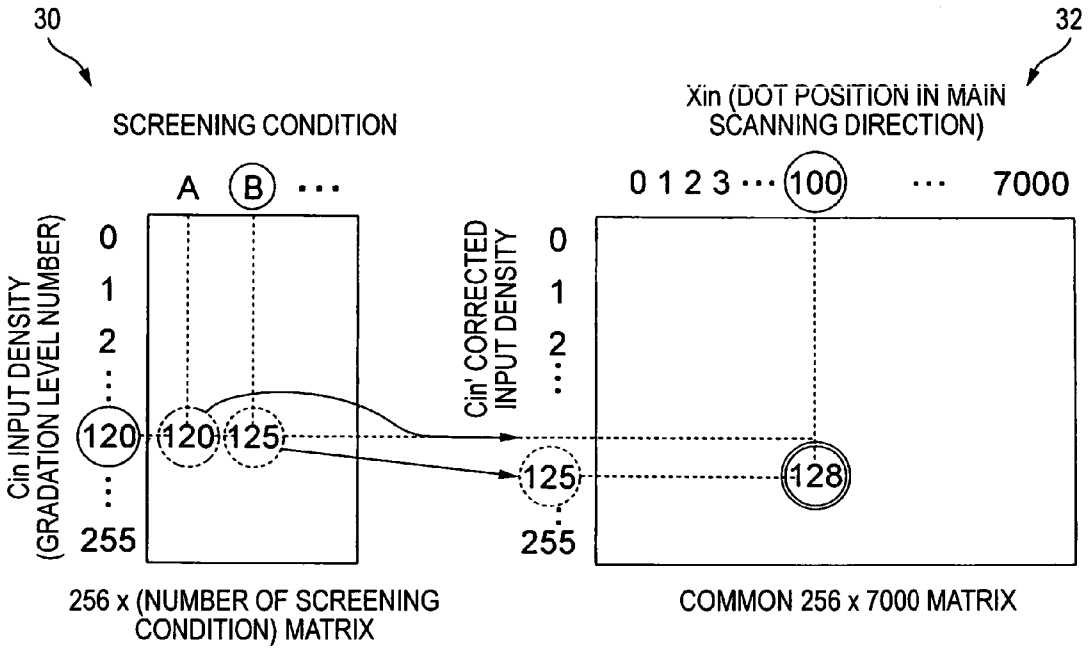

30
32
SCREENING CONDITION
A
B
Cin INPUT DENSITY (GRADATION LEVEL NUMBER)
0
1
2
120
120
125
255
256 x (NUMBER OF SCREENING CONDITION) MATRIX
Xin (DOT POSITION IN MAIN SCANNING DIRECTION)
0 1 2 3 100 7000
Cin' CORRECTED INPUT DENSITY
0
1
2
125
128
255
COMMON 256 x 7000 MATRIX

FIG. 3

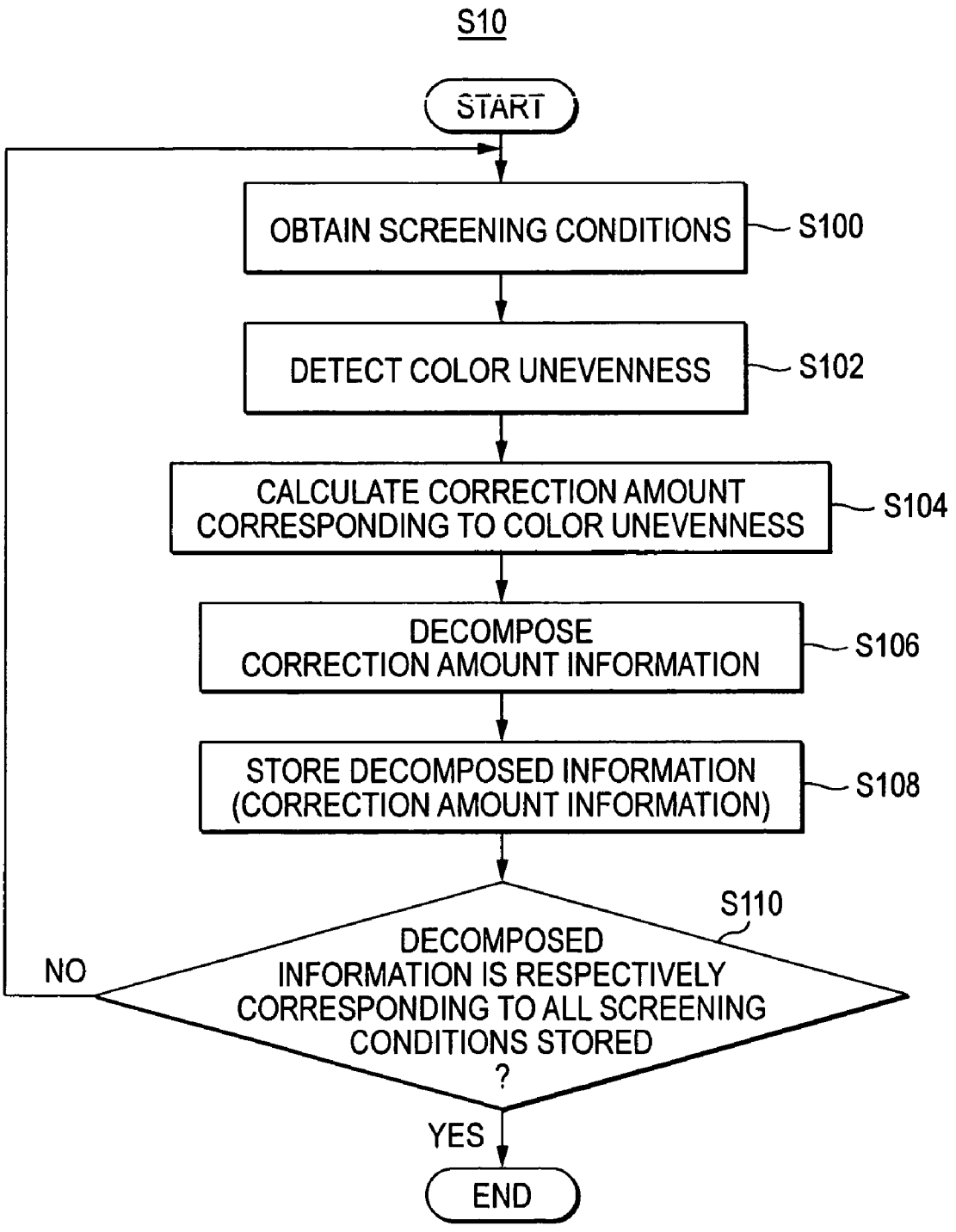

S10
START
OBTAIN SCREENING CONDITIONS
S100
DETECT COLOR UNEVENNESS
S102
CALCULATE CORRECTION AMOUNT CORRESPONDING TO COLOR UNEVENNESS
S104
DECOMPOSE CORRECTION AMOUNT INFORMATION
S106
STORE DECOMPOSED INFORMATION (CORRECTION AMOUNT INFORMATION)
S108
S110
DECOMPOSED INFORMATION IS RESPECTIVELY CORRESPONDING TO ALL SCREENING CONDITIONS STORED ?
NO
YES
END

FIG. 4

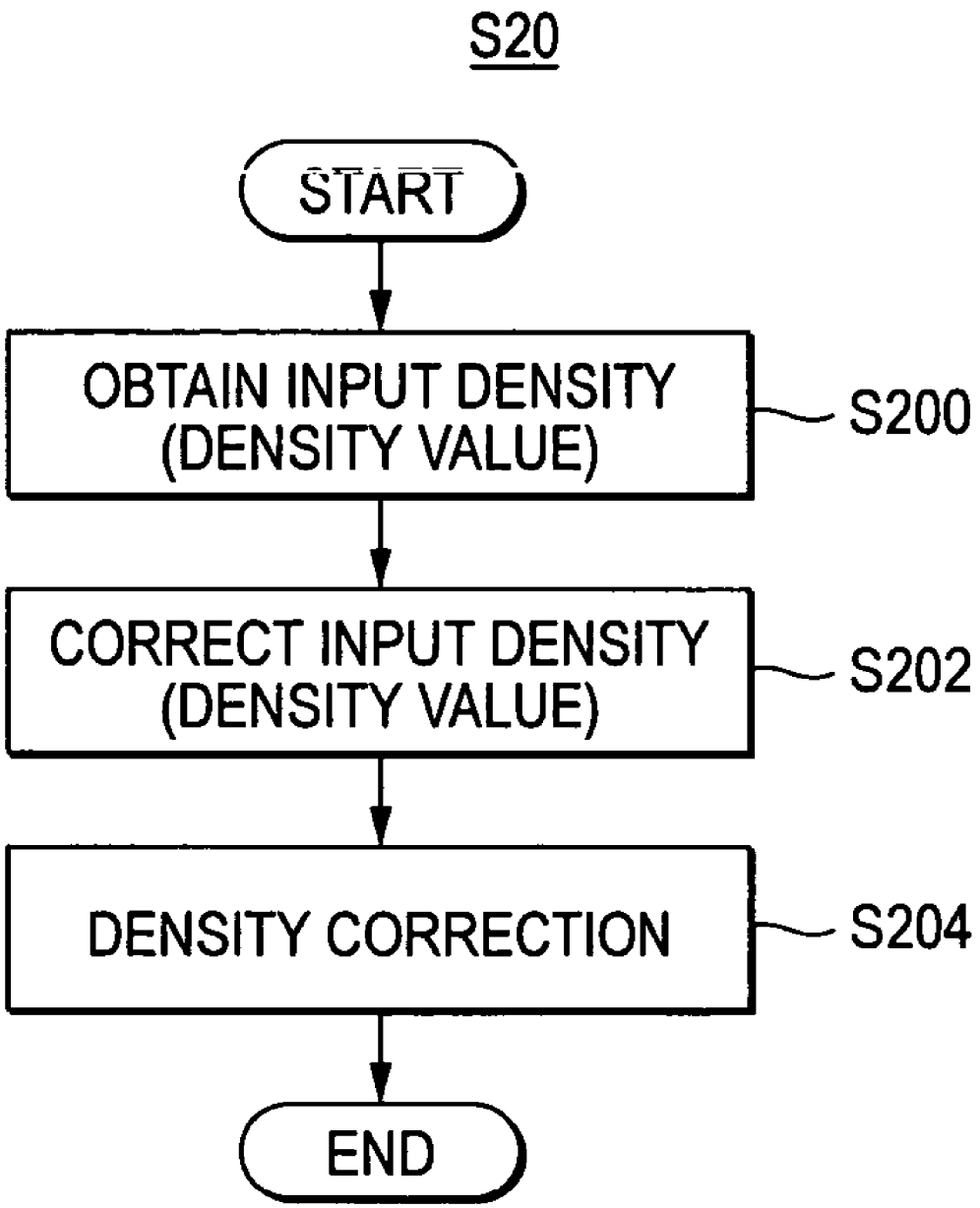

S20
START
OBTAIN INPUT DENSITY (DENSITY VALUE)
S200
CORRECT INPUT DENSITY (DENSITY VALUE)
S202
DENSITY CORRECTION
S204
END

FIG. 5

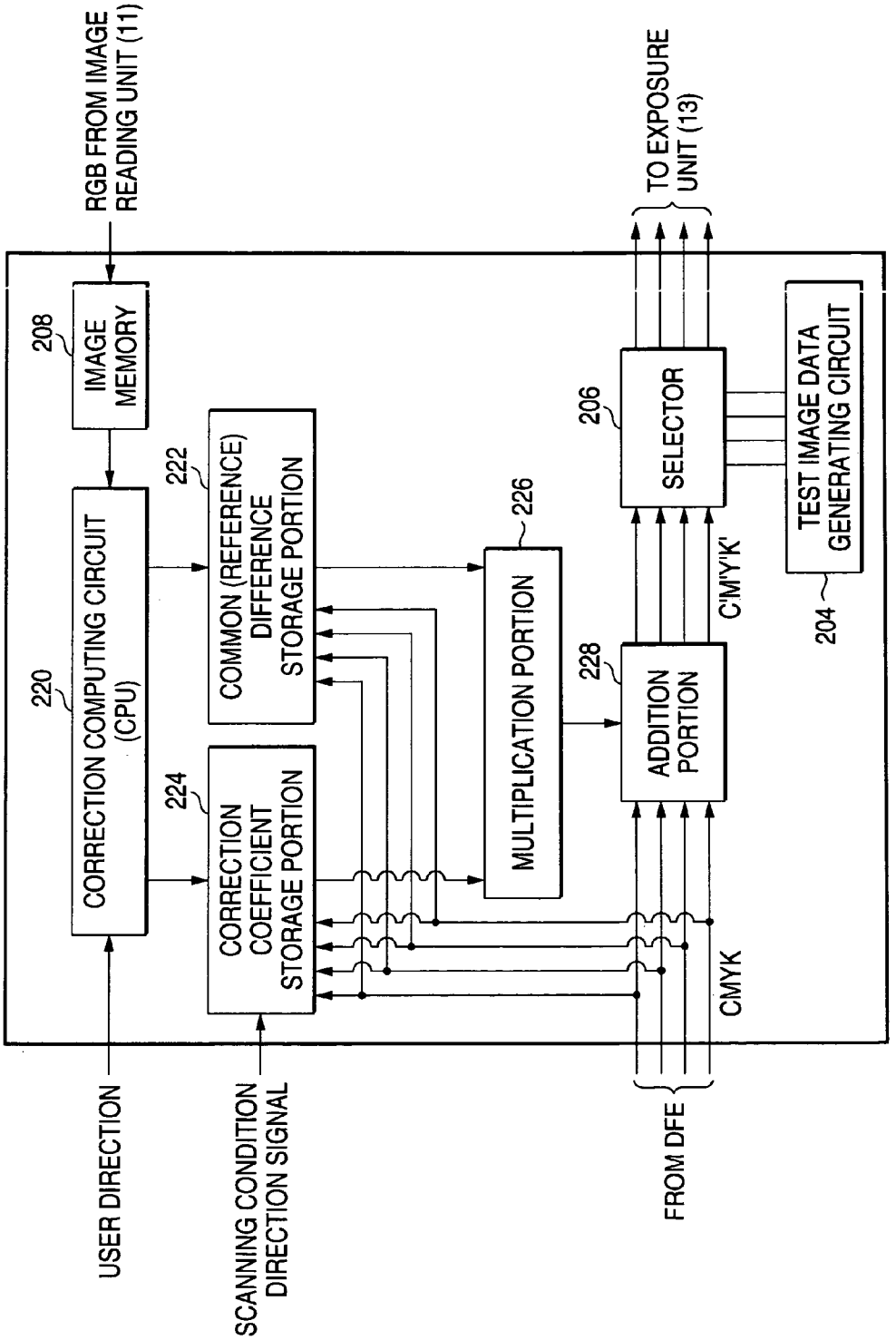

RGB FROM IMAGE READING UNIT (11)
TO EXPOSURE UNIT (13)
208
IMAGE MEMORY
220
CORRECTION COMPUTING CIRCUIT (CPU)
222
COMMON (REFERENCE) DIFFERENCE STORAGE PORTION
224
CORRECTION COEFFICIENT STORAGE PORTION
226
MULTIPLICATION PORTION
228
ADDITION PORTION
206
SELECTOR
204
TEST IMAGE DATA GENERATING CIRCUIT
C'M'Y'K'
CMYK
USER DIRECTION
SCANNING CONDITION DIRECTION SIGNAL
FROM DFE

FIG. 6A

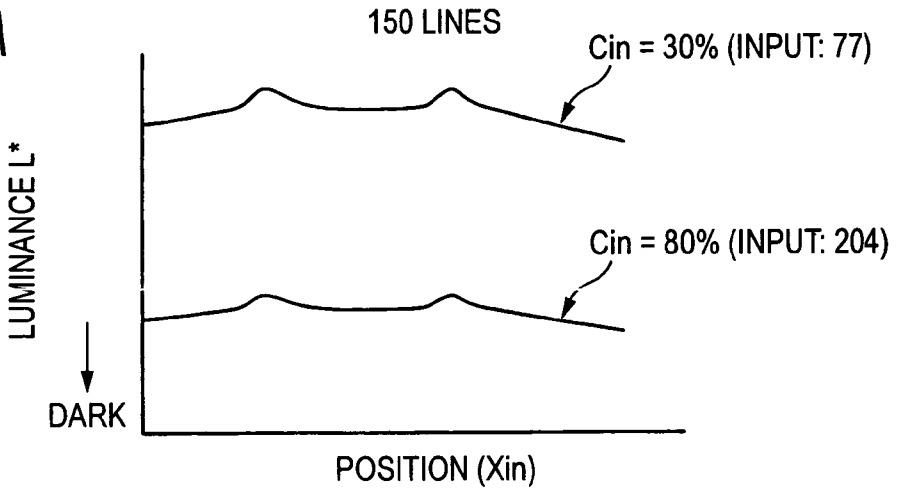


FIG. 6B

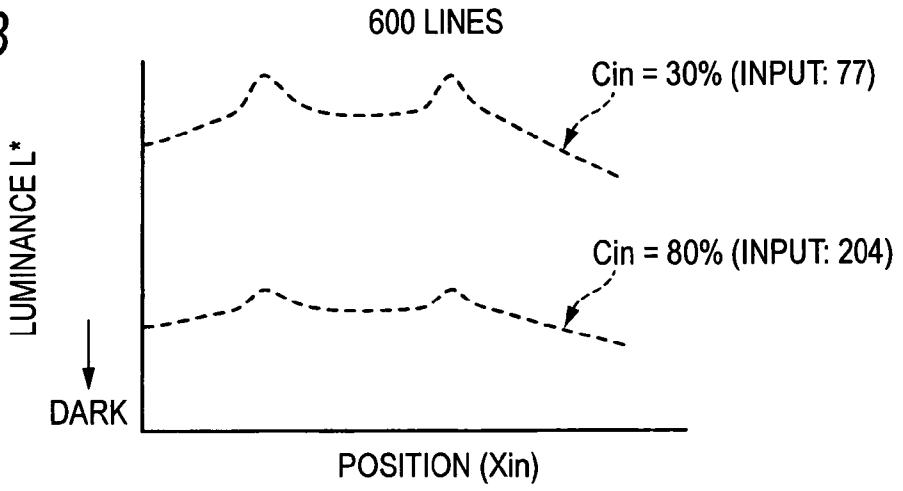


FIG. 6C

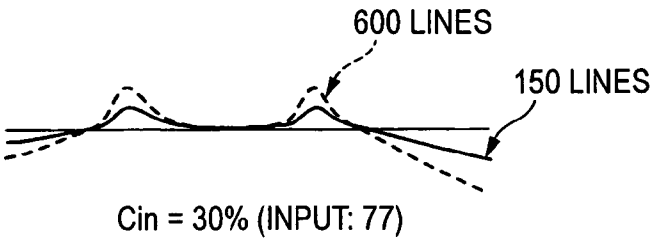


FIG. 6D

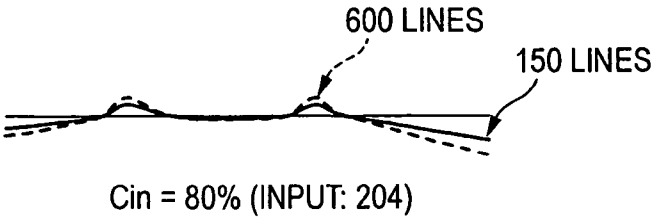


FIG. 7

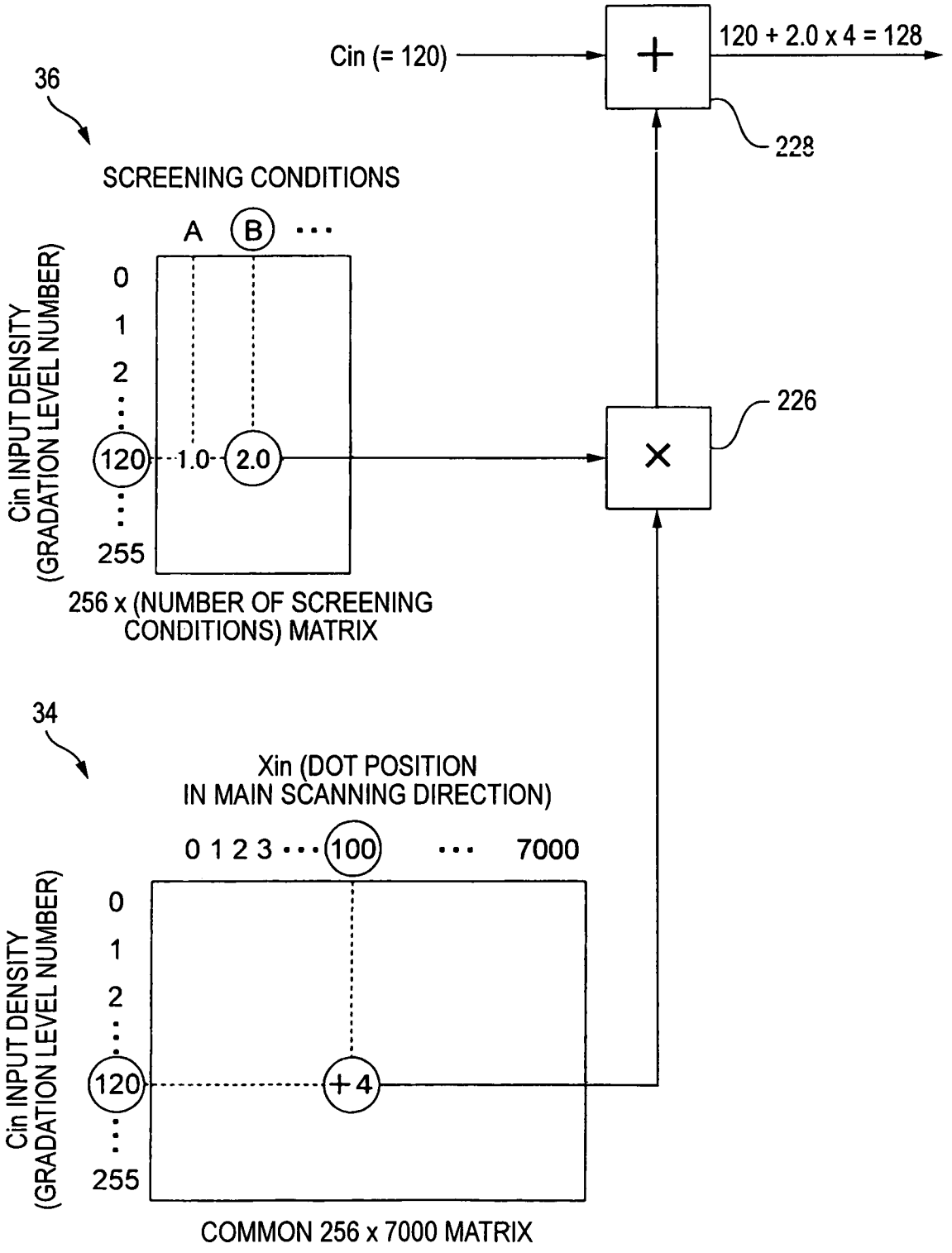

Cin (= 120)
120 + 2.0 x 4 = 128
228
36
SCREENING CONDITIONS
A
B
Cin INPUT DENSITY (GRADATION LEVEL NUMBER)
0
1
2
120
255
1.0
2.0
226
256 x (NUMBER OF SCREENING CONDITIONS) MATRIX
34
Xin (DOT POSITION IN MAIN SCANNING DIRECTION)
0 1 2 3 ··· 100 ··· 7000
+4
COMMON 256 x 7000 MATRIX

FIG. 8

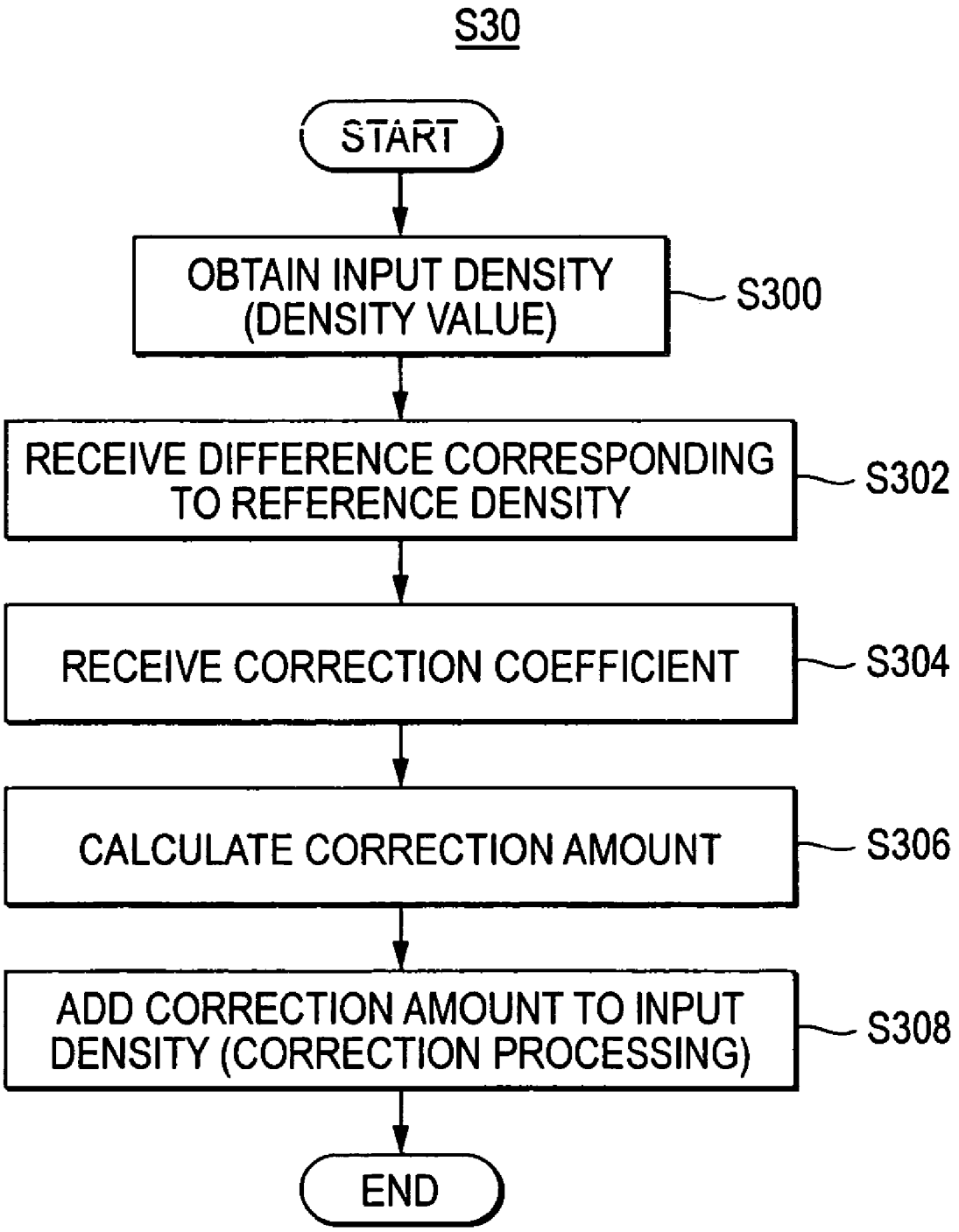

S30
START
OBTAIN INPUT DENSITY (DENSITY VALUE)
S300
RECEIVE DIFFERENCE CORRESPONDING TO REFERENCE DENSITY
S302
RECEIVE CORRECTION COEFFICIENT
S304
CALCULATE CORRECTION AMOUNT
S306
ADD CORRECTION AMOUNT TO INPUT DENSITY (CORRECTION PROCESSING)
S308
END

IMAGE PROCESSING APPARATUS AND IMAGE PROCESSING METHOD ADAPTED TO CORRECT COLOR UNEVENNESS

BACKGROUND

1. Technical Field

The present invention relates to an image processing apparatus and method, which are adapted to correct color unevenness of an image.

2. Related Art

It is known that an image forming apparatus obtains density data indicating density unevenness caused in an image, which is formed on a recording medium, is obtained by reading the image, and that the image forming apparatus corrects the density unevenness caused in the image.

SUMMARY

According to an aspect of the present invention, there is provided an image processing apparatus including: a storage unit that stores a correction amount used to correct color unevenness of an image according to a plurality of halftone screening conditions; and a correction unit that corrects an input image according to the correction amount stored in the storage unit; wherein the stored correction amount includes common information, which is common among the halftone screening conditions, and dependent information, which is dependent on the respective halftone screening conditions.

According to another aspect of the invention, there is provided an image processing apparatus including: a detection unit that detects color unevenness of an image according to a plurality of halftone screening conditions; a correction amount calculation unit that calculates a correction amount corresponding to the color unevenness detected by the detection unit; a correction amount division unit that divides the correction amount into a common information which is common among the halftone screening conditions, and dependent information which is dependent on the respective halftone screening conditions; a storage unit that stores the common information and the dependent information; a correction unit that corrects the image according to the correction amount stored in the storage unit.

According to still another aspect of the invention, there is provided an image processing apparatus including: a print unit that prints an image on a recording medium according to a plurality of halftone screening conditions; a detection unit that detects color unevenness of the image printed by the print unit; a correction amount calculation unit that calculates a correction amount corresponding to color unevenness detected by the detection unit; a correction amount division unit that divides the correction amount calculated by the correction amount calculation unit into common information, which is common among the halftone screening conditions, and dependent information, which is dependent on the respective halftone screening conditions; a storage unit that stores the common information and the dependent information; and a control unit that controls the print unit to print the image based on the correction amount stored in the storage unit.

Further, according to a further aspect of the invention, there is provided an image processing method including: storing a correction amount used to correct color unevenness of an image according to a plurality of halftone screening conditions; and correcting an input image according to the stored correction amount; wherein the correction amount includes common information, which is common among the halftone screening conditions, and dependent information, which is dependent on the respective halftone screening conditions.

According to a still further aspect of the invention, there is provided an image processing apparatus comprising: a storage unit that stores a correction amount used to correct color unevenness of an image; and a correction unit that corrects an input image according to the correction amounts stored in the storage unit, wherein the correction amount includes a density correction amount which is common among a plurality of halftone screening conditions, the density correction amount corresponding to positions in a main scanning direction, and a density correction amount which is not common among the plurality of the halftone screening conditions.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** is a side diagram illustrating an outline of an image processing apparatus according to an embodiment of the invention;

FIG. **2** is a diagram illustrating the configuration of each of a condition dependent correction table and a common density correction table corresponding to a cyan (C) image;

FIG. **3** is a flow chart illustrating a process S**10** of a control portion that creates the condition dependent correction table and the common density correction table, which are used to correct color unevenness;

FIG. **4** is a flowchart illustrating a process S**20** of the control portion that corrects color unevenness in an image obtained from a DFE according to the condition dependent correction table and the common density correction table;

FIG. **5** is a diagram illustrating the configuration of a modification of the control portion;

FIGS. **6**A to **6**D are graphs illustrating the tendencies of occurrence of color unevenness, which is generated in an image (the cyan image) by the image processing apparatus; FIG. **6**A is a graph illustrating a case where images are respectively formed at different densities C_{in} of 30% and 80% by screening using 150 screen lines; FIG. **6**B is a graph illustrating a case where images are respectively formed at the different densities by the screening using 600 screen lines; FIG. **6**C is a graph illustrating a case where images are respectively formed at the same density by the screening using 600 screen lines and 150 screen lines; and FIG. **6**D is a graph illustrating a case where images are respectively formed at the same density, which is higher than the density used in the case illustrated in FIG. **6**C (the luminance used in the case illustrated in FIG. **6**D is lower than that used in the case illustrated in FIG. **6**C), by the screening using 600 screen lines and 150 screen lines;

FIG. **7** is a conceptual diagram illustrating an operation of a modification of the control portion that corrects image data representing the cyan (C) image;

FIG. **8** is a flowchart illustrating a process S**30** of the control portion that corrects color unevenness in an image obtained from the DFE according to a common difference table and a correction coefficient table.

DETAILED DESCRIPTION

Next, an embodiment of the invention is described below with reference to the accompanying drawings.

FIG. **1** shows an outline of an image processing apparatus **10** according to an embodiment of the invention. The image processing apparatus **10** includes an image reading unit **11**, an exposure unit **13**, a plurality of image forming units **14**, an

intermediate transfer belt **16**, recording-medium trays **17***a* to **17***d*, a recording medium conveying path **18**, a fixing unit **19**, and a control portion **20**. Imaged at a respectively corresponding to C (cyan), M (magenta), Y (yellow), and K (black) are obtained from a DFE (Digital Front End), such as a computer or a server, which is not shown, in response to a user's operation. Then, an image is printed on a recording medium, such as paper. Incidentally, the image processing apparatus **10** may include a terminal unit, such as a computer, connected through a network as a component of a system. The control portion **20** is disposed at a certain place in the system.

The image reading unit **11** is disposed at an upper part of the image processing apparatus **10**. The image reading unit **11** is a scanner adapted to read an image by decomposing the image into R (red), G (green) and B (bluish purple) components. The image reading unit **11** reads, for example, a test image, which is printed by the image processing apparatus **10**, and outputs R-, G-, and B-component image data of the test image to the control portion **20**.

An exposure unit **13** is disposed under the image reading unit **11**. The exposure unit **13** includes a light source (not shown) and lenses (not shown) and outputs modulated laser light beams, which respectively correspond to the colors Y, M, C, and K according to image data inputted from the control portion **20**, to the plurality of image forming units **14** disposed under the exposure unit **13**.

The plurality of image forming units **14** are disposed corresponding to the colors of a color image, respectively. In this embodiment, a first image forming unit **14**Y, a second image forming unit **14**M, a third image forming unit **14**C, and a fourth image forming unit **14**K respectively corresponding to yellow (Y), magenta (M), cyan (C), and black (K) are disposed at constant intervals along the intermediate transfer belt **16** in a horizontal direction. The intermediate transfer belt **16** serving as an intermediate transfer element is turned in the direction of an arrow a shown in the figure. The four image forming units **14**Y, **14**M, **14**C, and **14**K form toner images of the colors Y, M, C, and K according to image data inputted from the control portion **20** sequentially. Then, the image forming units **14**Y, **14**M, **14**C, and **14**K perform the (primary) transfer of the toner images to the intermediate transfer belt **16** so that plural toner images are overlapped with one another. The order of the colors respectively corresponding to the image forming units **14**Y, **14**M, **14**C, and **14**K is not limited to a certain order and is optional.

The recording medium conveying path **18** is disposed under the intermediate transfer belt **16**. A recording medium supplied from one of the recording medium trays **17***a* to **17***d* is conveyed on the recording medium conveying path **18**. Thus, the toner images respectively corresponding to the colors, which are multiply transferred onto the intermediate transfer belt **16**, are collectively transferred (as a secondary transfer). The transferred toner images are fixed by the fixing unit **19**. Then, the recording media having the fixed toner images are externally discharged along the direction of an arrow b.

Next, each of the components of the image processing apparatus **10** is described in more detail below.

The image reading unit **11** has a platen glass **11**, on which an original P of, for instance, a test image is placed, a platen cover **112** adapted to press the original P against the platen glass **110**, and an image reading portion **120** adapted to read an image, which is formed on the original P placed on the platen glass **110**, by decomposing the image into three component images, that is, R-, G-, and B-component images. The image reading unit **11** outputs the components images which are read by decomposing to the control portion **20**. The image reading portion **120** illuminates the original P, which is placed on the platen glass **110**, with light from the light source **122**. An image formed from reflection light reflected by the original P is scanned and exposed on an image reading element **126**, which includes three CCDs, through a reduction optical system including a plurality of mirrors **124**. The image formed on the original P is read by the image reading element **126** by being decomposed into three component images, that is, the R-, G-, and B-component images each having a predetermined dot density.

The first image forming unit **14**Y, the second image forming unit **14**M, the third image forming unit **14**C, and the fourth image forming unit **14**K are arranged in a horizontal direction at constant intervals in parallel with one another, and are substantially similarly constructed, except for the color of formed images. Thus, hereinafter, the first image forming unit **14**Y is described by way of example. Incidentally, the components of the image forming units **14** are distinguished from one another by letters Y, M, C, and K included in reference characters that designate such components.

The image forming unit **14**Y includes an optical scanning device **140**Y and an image forming device **150**Y.

The optical scanning device **140**Y is configured to deflection-scan laser light corresponding to yellow (Y) inputted from the exposure unit **13** by using a rotating polygon mirror **142**Y, and to irradiate the laser light onto a photoconductor drum **152**Y of the image forming device **150**Y.

The image forming device **150**Y includes the photoconductor drum **152**Y which rotates along the direction of an arrow a at a predetermined rotating speed and serves as an image bearing element, an electrification device **154**Y adapted to uniformly electrify the surface of this photoconductor drum **152**Y, a developing device **156**Y adapted to develop an electrostatic latent image formed on the photoconductor drum **152**Y, a cleaning device **158**Y, and a neutralization device **159**Y. The surface of the photoconductor drum **152**Y is uniformly electrified by the electrification device **154**Y. An electrostatic latent image is formed thereon by laser light irradiated by the optical scanning device **140**Y. The electrostatic latent image formed on the photoconductor drum **152**Y is developed by using yellow toner by a developer **156**Y, and is then transfer onto the intermediate transfer belt **16**. Incidentally, after the process of transferring the toner image, residual toner and paper powder adhering to the photoconductor drum **152**Y are removed by the cleaning device **158**Y. Also, electricity is removed from the photoconductor drum **152**Y by the neutralization device **159**Y.

Similarly, the other image forming units **14**M, **14**C, and **14**K are adapted to form toner images of magenta (M), cyan (C) and black (K) and to transfer the formed toner images onto the image transfer belt **16**.

The intermediate transfer belt **16** is laid around a drive roll **160**, an idle roll **162**, a steering roll **164**, and a backup roll **166**, with certain tension. The intermediate transfer belt **16** is circulation-driven in the direction of the arrow a at a predetermined speed by causing a drive motor (not shown) to rotation-drive the drive roll **160**. This intermediate transfer belt **16** is formed like an endless belt by forming a flexible film made of a synthetic resin, such as polyamide, like a belt and by connecting both ends of this synthetic resin film, which is formed like a belt, to each other by welding.

Also, a first primary transfer roll **168**Y, a second primary transfer roll **168**M, a third primary transfer roll **168**C, and a fourth primary transfer roll **168**K are disposed on the intermediate transfer belt **16** at places facing the image forming units **14**Y, **14**M, **14**C, and **14**K, respectively. Toner images of the colors Y, M, C, and K respectively formed on the photo-

conductor drum **152**Y, **152**M, **152**C, and **152**K are multiply transferred on the intermediate transfer belt **16** by these primary transfer rolls **168**.

Paper feeding rollers **180**, which are used to take out recording media respectively from the recording medium trays **17***a* to **17***d*, and a recording-medium conveying roller pair **182**, and resist rolls **184**, which are used to convey a recording medium to a secondary transfer position with predetermined timing, are disposed on the recording medium conveying path **18**.

Also, a secondary transfer roll **186** pressure-contacted with the backup roll **166** is disposed at the secondary transfer position on the recording medium conveying path **18**. The toner images respectively corresponding to the colors multiply transferred onto the intermediate transfer belt **16** are transferred onto a recording medium by a secondary transfer utilizing a pressure-contacting force and an electrostatic force due to the secondary transfer roll **186**. The recording medium onto which the toner images respectively corresponding to the colors are transferred is conveyed to the fixing unit **19**.

The fixing unit **19** is adapted to fix toner onto a recording medium by applying heat and a pressure to the recording medium, onto which the toner images respectively corresponding to the colors are transferred.

The control portion **20** has an input density conversion portion **200**, a common correction portion **202**, a test image data generating circuit **204**, a selector **206**, an image memory **208**, and a correction computing circuit **210**.

The input density conversion portion **200** includes a memory **212** adapted to store a condition dependent correction table **30** (to be described later) corresponding to each of the colors. The input density conversion portion **200** obtains image data (representing input densities in terms of density values) respectively corresponding to the colors C, M, Y, and K from the DFE, such as a computer or a server (not shown). Also, the input density conversion portion **200** corrects the obtained input density corresponding to each of the colors C, M, Y, and K according to the condition dependent correction table **30** corresponding to each of the colors, which is received from the correction computing circuit **210**, in response to a screening condition direction signal inputted through a user interface (UI), which is not shown. Subsequently, the input density conversion portion **200** outputs the corrected input density to the common correction portion **202**.

Incidentally, information represented by the screening condition direction signal which is received by the input density conversion portion **200** includes information representing, for example, the number of screen lines, a screen angle, and the shapes of halftone dots. The following description of this embodiment describes a case where the screen angle is set at a constant value and the shape of the halftone dots is set to be a certain shape according to the information represented by the screening condition direction signal, and where a plurality of the numbers of screen lines are designated by the screening condition direction signal, by way of example.

The common correction portion **202** includes the memory **214** adapted to store the common density correction table **32** corresponding to each of the colors, which will be described later. The common correction portion **202** obtains the corrected input density from the input density conversion portion **200**, and corrects the corrected input density obtained therefrom according to the common density correction table **32**, which is received from the correction computing circuit **210** and corresponds to each of the colors C, M, Y, and K at each of dot positions arranged in a main scanning direction. Then, the common correction portion **202** outputs resultant corrected input densities to the selector **206**.

The test image data generating circuit **204** generates test image data, which is used to form an uneven color correction test image corresponding to each of the colors C, M, Y, and K, and outputs the generated test image data to the selector **206**.

The selector **206** is adapted to obtain setting-information indicating which of a mode (an ordinary print mode), in which an image is printed according to image data corresponding to each of the colors C, M, Y, and K obtained from the DFE, and a mode (a test mode), in which the color unevenness (color shading) of an image to be printed is corrected, is selected as an operation mode in which the image processing apparatus **10** operates, through, for example, a user interface (not shown). Thereafter, the selector **206** outputs image data, which is selected according to the obtained setting-information, to the exposure unit **13**. That is, the selector **206** selects and outputs image data inputted from the common correction portion **202** in the case of obtaining the setting information indicating that the apparatus **10** operates in the ordinary print mode. However, the selector **206** selects and outputs image data inputted from the test image data generating circuit **204** in the case of obtaining the setting information indicating that the apparatus **10** operates in the test mode.

The image memory **208** is adapted to receive and store three component images (respectively represented by three pieces of image data), which are outputted by the image reading unit **11** and respectively correspond to the colors R, G, and B. The image memory **208** is also adapted to output the image data to the correction computing circuit **210** in response to an access made by the correction computing circuit **210**.

The correction computing circuit **210** includes, for instance, a CPU, and is adapted to receive a user's direction through a user interface (not shown). Also, the correction computing circuit **210** is adapted to receive the images, which respectively correspond to the colors R, G, and B, and to detect color unevenness in each of the images respectively corresponding to the colors C, M, Y, and K, which is generated by the image processing apparatus **10**, by detecting color unevenness in the obtained image. Incidentally, the corresponding relation between the density values of the images of the colors C, M, and Y and the density values of the images of the colors R, G, and B is set by preliminarily measuring the density values of the images of the colors R, G, and B, which correspond to those of known images of the colors C, M, and Y.

In a case where color unevenness is detected, the correction computing circuit **210** calculates correction amounts (density conversion amounts) used to correct the images, in each of which the color unevenness is detected, to prevent an occurrence of color unevenness. Then, the correction computing circuit **210** decomposes each of the correction amounts into a common correction amount, which is common among the plurality of halftone screening conditions, and a screening-condition-dependent correction amount which is used to correct the difference in color unevenness, which depends on the halftone screening conditions. Also, the correction computing circuit **210** generates the common density correction table **32**, which is common among the plurality of halftone screening conditions, and the condition dependent correction table **30** that is used to correct the difference in color unevenness, which depends on the screen conditions, corresponding to each of the colors C, M, Y, and K. Subsequently, the correction computing circuit **210** outputs the condition dependent correction table **30** to the input density conversion portion

200, and also outputs the common density correction table **32** to the common correction portion **202**.

FIG. **2** is a diagram illustrating the configuration of each of the condition dependent correction table **30** and the common density correction table **32** corresponding to a cyan (C) image.

As illustrated in FIG. **2**, the condition dependent correction table **30** corresponding to, for example, cyan (C) associates correction values of the input densities (C_{in}': corrected input densities), which correspond to each of the plurality of different halftone screening conditions, with the input densities C_{in} (gradation level numbers ranging from 0 to 255) of the cyan (C) image to correct the difference in color unevenness, which depends on the halftone screening conditions. The screening condition A is that the number of screen lines is, for instance, 150. The screening condition B is that the number of screen lines is, for example, 600.

Thus, the condition dependent correction table **30** is represented by a matrix including correction values, the number of which is given by multiplying the number of gradation levels (256) by the number of halftone screening conditions, which can be printed by the image processing apparatus **10**. Incidentally, the number of bits needed to designate the density of one dot (one pixel) is 8 (8 bits=1 byte). Therefore, in a case where the number of halftone screening conditions is 6, the capacity of the memory **212**, which is necessary for storing the condition dependent correction table **30** corresponding to one of the colors C, M, Y, and K, is 1536 bytes (256×6×8 bits).

Also, as illustrated in FIG. **2**, the common density correction table **32** corresponding to, for example, cyan (C) associates a correction value of each of the input densities, which is common among the plurality of halftone screening conditions, with the corrected input density C_{in}' (a gradation level number ranging from 0 to 255) of the cyan (C) image to correct the corrected input density at a dot position X_{in} (ranging from 0 to 7000) located in the main scanning direction of the third image forming unit **14**C.

Thus, the common density correction table **32** is represented by a matrix including correction values, the number of which is given by multiplying the number of gradation levels (256) by the number of dots in the main scanning direction of each of the image forming units **14**. Because the number of bits needed to designate the density of one dot (pixel) is 8 (1 byte), the capacity of the memory **214**, which is necessary for storing the common density correction table **32** corresponding to one of the colors C, M, Y, and K, is 1792 Kbytes (256×7000×8 bits).

Because the control portion **20** has the memory whose capacity is about 1.8 Mbytes, the control portion **20** can store the condition dependent correction table **30** and the common density correction table **32**, which correspond to one of the colors C, M, Y, and K. Thus, as compared with a case where density correction values corresponding to each of the halftone screening conditions are stored (a memory, whose capacity is 256×7000×8×(the number of halftone screening conditions), is needed), the necessary capacity of the memory can be reduced.

Incidentally, to generate the condition dependent correction table **30** and the common density correction table **32**, the image processing apparatus **10** prints test images respectively corresponding to the colors C, M, Y, and K one by one in response to a user's operation. The test images respectively corresponding to the colors C, M, Y, and K are set to have the same density in the main scanning direction to correct color unevenness occurring, for instance, in the main scanning direction. Also, the test images respectively corresponding to the colors C, M, Y, and K are set so that the density value (ranging from 0 to 255) increases in the sub-scanning direction. That is, the correction computing circuit **210** obtains image data, which respectively correspond to the colors R, G, and B and are read from the test images of the colors C, M, Y, and K, from the image memory **208**. Then, the correction computing circuit **210** creates the condition dependent correction table **30** and the common density correction table **32** to correct color unevenness in the image represented by the image data corresponding to the colors C, M, Y, and K.

Next, a process of creating the condition dependent correction table **30** and the common density correction table **32**, which are used to correct color unevenness, by the control portion **20** is described below.

FIG. **3** is a flowchart illustrating a process S**10** of the control portion **20** that creates the condition dependent correction table **30** and the common density correction table **32**, which are used to correct color unevenness.

As illustrated in FIG. **3**, in step **100** (S**100**), the correction computing circuit **210** receives the halftone screening conditions corresponding to the image data, which is received from the image memory **208**, through the user interface (not shown).

In step **102** (S**102**), the correction computing circuit **210** obtains the image data from the image memory **208** and detects color unevenness (or color shading). For example, the correction computing circuit **210** detects color unevenness in each of density value patterns generated corresponding to each of the positions in the main scanning direction of each of the image forming units **14** so that the density value increases stepwise.

In step **104** (S**104**), the correction computing circuit **210** calculates a correction amount (a density conversion amount) used to correct the image, in which color unevenness is detected, to prevent an occurrence of color unevenness.

In step **106** (S**106**), the correction computing circuit **210** decomposes the calculated correction amount into a common density correction amount, which is common among the plurality of halftone screening conditions, and a condition dependent correction amount used to correct the difference in color unevenness, which depends on the halftone screening conditions. Thus, the correction computing circuit **210** creates the common density correction table **32**, which is common among the plurality of halftone screening conditions, and the condition dependent correction table **30** used to correct the difference in color unevenness, which depends on each of the halftone screening conditions.

In step **108** (S**108**), the memory **212** stores the condition dependent correction table **30**, while the memory **214** stores the common density correction table **32**. Thus, the control portion **20** stores data (representing the correction amounts) decomposed by the correction computing circuit **210**.

In step **110** (S**110**), the correction computing circuit **210** determines whether the image processing circuit **10** stores the correction amounts for all the corresponding halftone screening conditions in response to the user's direction received through the user interface (not shown). If the image processing circuit **10** does not store such correction amounts, the process proceeds to step S**100**. If the image processing circuit **10** stores such correction amounts, the process is finished.

Incidentally, the process S**10** is performed on, for example, each of the test images respectively corresponding to the colors C, M, Y, and K.

Next, a process of correcting color unevenness in an image obtained from the DFE by the control portion **20** using the condition dependent correction table **30** and the common density correction table **32** is described below.

FIG. **4** is a flowchart illustrating the process S**20** of the control portion **20** that corrects color unevenness in an image obtained from the DFE according to the condition dependent correction table **30** and the common density correction table **32**.

As illustrated in FIG. **4**, in step **200** (S**200**), the input density conversion portion **200** obtains image data (representing the input densities indicated by density values) corresponding to the colors C, M, Y, and K.

For example, the input density conversion portion **200** obtains the input density C_{in}, whose density value is **120**, corresponding to a dot, whose dot position X_{in} in the main scanning direction is **100**.

In step **202** (S**202**), the input density conversion portion **200** corrects the obtained input density corresponding to each of the colors C, M, Y, and Kin response to the screening condition direction signal, which is inputted through the user interface (UI (not shown)), according to the condition dependent correction table **30** corresponding to each of the colors. Then, the input density conversion portion **200** outputs the corrected input densities to the common correction portion **202**.

For example, as illustrated in FIG. **2**, in a case where the screening condition inputted to the input density conversion portion **200** through the UI is the screening condition B (the number of screen lines is 600) and where the input density conversion portion **20** obtains the input density C_{in} (the density value=120) corresponding to a dot, whose dot position X_{in} in the main scanning direction is 100, the input density conversion portion **200** corrects the input density C_{in} by changing the density value of 120 to a density value of 125 corresponding to the screening condition B. Then, the input density conversion portion **200** outputs the density value of 125 as the corrected input density C_{in}' to the common correction portion **202**.

Incidentally, in a case where the common density correction table **32** is created according to, for instance, the screening condition A, the input density C_{in}, that is, the density value of 120 is outputted to the common correction portion **202** as the corrected input density C_{in}' without changing the density value according to the condition dependent correction table **30**.

In step **203** (S**204**), the common correction portion **202** corrects the corrected input density corresponding to each of the colors C, M, Y, and K, which is obtained from the input density conversion portion **200**, at each of dot positions in the main scanning direction of each of the image forming units **14** according to the common density correction table **32** corresponding to each of the colors. Then, the common correction portion **202** outputs resultant corrected input densities to the selector **206**.

For instance, as illustrated in FIG. **2**, in a case where the common correction portion **202** obtains the corrected input density C_{in}', whose density value is 125, corresponding to the dot position in the main scanning direction X_{in}=100, the common correction portion **202** corrects the density value of the corrected input density C_{in}' to a density value of 128 corresponding to the position X_{in}=100. Then, the common correction portion **202** outputs the density value of 128 to the selector **206**.

Next, a modification of the control **20** is described below.

FIG. **5** is a diagram illustrating the configuration of a modification (a control portion **20'**) of the control portion **20**.

As illustrated in FIG. **5**, the control portion **20'** includes a correction computing circuit **220**, a common (reference) difference storage portion **222**, a correction coefficient storage portion **224**, a multiplication portion **226**, an addition portion (a correction processing portion) **228**, a test data generating circuit **204**, a selector **206**, and an image memory **208**.

Incidentally, components of the control portion **20'** shown in FIG. **5**, which are the substantially same as the components of the control portion **20** shown in FIG. **1**, are designated by the same reference characters as those used to designate the substantially same components of the control portion **20**.

The correction computing circuit **220** includes, for example, a CPU, and is adapted to receive a user's direction through a user interface (not shown). Also, the correction computing circuit **220** is adapted to receive the images, which respectively correspond to the colors R, G, and B, and to detect color unevenness in each of the images respectively corresponding to the colors C, M, Y, and K, which is generated by the image processing apparatus **10**, by detecting color unevenness in the obtained image. Incidentally, the corresponding relation between the density values of the images of the colors C, M, and Y and the density values of the images of the colors R, G, and B is set by preliminarily measuring the density values of the images of the colors R, G, and B, which correspond to those of known images of the colors C, M, and Y.

Further, in a case where color unevenness is detected, the correction computing circuit **220** calculates correction amounts (density conversion amounts) used to correct the images, in each of which the color unevenness is detected, to prevent an occurrence of color unevenness. Then, the correction computing circuit **220** decomposes each of the calculated correction amounts according to the tendencies of occurrence of color unevenness (to be described later) into a density difference corresponding to a predetermined density, which is common among the plurality of halftone screening conditions, and a screening-condition-dependent correction coefficient which is used to correct the difference in color unevenness, which depends on the halftone screening conditions. Also, the correction computing circuit **220** generates a common (reference) density difference table **34**, which is common among the plurality of halftone screening conditions, and a correction coefficient table **36** that is used to correct the difference in color unevenness, which depends on the screen conditions, corresponding to each of the four kinds of colors C, M, Y, and K.

FIGS. **6**A to **6**D are graphs illustrating the tendencies of occurrence of color unevenness, which is generated in an image (the cyan image) by the image processing apparatus **10**. FIG. **6**A is a graph illustrating a case where images are respectively formed at different densities C_{in} of 30% and 80% by screening using 150 screen lines. FIG. **6**B is a graph illustrating a case where images are respectively formed at the different densities by the screening using 600 screen lines. FIG. **6**C is a graph illustrating a case where images are respectively formed at the same density by the screening using 600 screen lines and 150 screen lines. FIG. **6**D is a graph illustrating a case where images are respectively formed at the same density, which is higher than the density used in the case illustrated in FIG. **6**C (the luminance used in the case illustrated in FIG. **6**D is darker (or lower) than that used in the case illustrated in FIG. **6**C), by the screening using 600 screen lines and 150 screen lines.

As shown in FIGS. **6**A to **6**D, an image, whose C_{in}=30% (an input density value=77), has a tendency that the difference in density, which corresponds to a difference in the position in the main scanning direction X_{in}, is larger than the difference in density, which corresponds to the same difference in the position in the main scanning direction X_{in}, in an image whose C_{in}=80% (an input density value=204). That is, the lower the density of the image, the larger the magnitude of the

unevenness in color in the image. Also, an image outputted by setting the number of screen lines at 600 has a tendency that the difference in density, which corresponds to a difference in the position in the main scanning direction X_{in}, is larger than the difference in density, which corresponds to the same difference in the position in the main scanning direction X_{in}, in an image outputted by setting the number of screen lines at 150. That is, the larger the number of screen lines, the larger the magnitude of the unevenness in color in the image.

Incidentally, the frequency of occurrence of color unevenness in an image varies according to the halftone screening conditions and to the input density of the image. However, it is seen from these graphs that color unevenness frequently occurs at the substantially same position in the main scanning direction X_{in}. Thus, the correction computing circuit **220** can divide the correction amount for color unevenness into a density difference corresponding to a predetermined density, which is common among the plurality of halftone screening conditions, and a correction coefficient used to correct a color unevenness difference, which depends on the halftone screening conditions.

Then, the correction computing circuit **220** (see FIG. **5**) generates the common difference table **34** and the correction coefficient table **36**. Subsequently, the correction computing circuit **220** outputs the common difference table **34** to the common difference storage portion **222**, and also outputs the correction coefficient table **36** to the correction coefficient storage portion **224**.

The common difference storage portion **222** receives the common difference table **34** corresponding to each of images of the colors C, M, Y, and K from the correction computing circuit **220** and stores the received common difference table **34**. Also, the common difference storage portion **222** obtains a density difference corresponding to the predetermined density of each of the images of the colors C, M, Y, and K, which are inputted from the DFE, according to the common difference table **34** and then outputs the obtained density difference.

The correction coefficient storage portion **224** receives the correction coefficient table **36**, which shows a coefficient corresponding to the common difference table **34** used to correct the color unevenness difference depending on the halftone screening conditions, from the correction computing circuit **220** and stores the received correction coefficient table **36**. Then, the correction coefficient storage portion **224** outputs a coefficient, which corresponds to the common difference table **34** used to correct the color unevenness difference depending on the halftone screening conditions, to the multiplication portion **226** according to the screening condition direction signal inputted from the user interface (not shown) and to the input density of each of the images of the colors C, M, Y, and K inputted from the DFE.

The multiplication portion **226** receives the density difference, which corresponds to the input density of each of the input densities of the images of the colors C, M, Y, and K, from the common difference storage portion **222** and also receives the coefficient from the correction coefficient storage portion **224**. Then, the multiplication portion **226** multiplies the received difference by the received coefficient corresponding to each of the dot positions in the main scanning direction of each of the images of the colors C, M, Y, and K, and outputs a result of the multiplication as the correction amount to the addition portion **228**.

The addition portion **228** receives the images of the colors C, M, Y, and K inputted from the DFE and then adds the correction amount, which is inputted from the multiplication portion **226**, to the input density of each of the received images to thereby correct each of the images. Then, the addition portion **228** outputs the corrected image to the selector **206**.

Next, a process of correcting color unevenness of the image obtained from the DFE by the control portion **20'** according to the common difference table **34** and the correction coefficient table **36** is described below.

FIG. **7** is a conceptual diagram illustrating a process of a modification of the control portion **201** that corrects image data representing the cyan (C) image (the image data).

The common (reference) difference table **34** associates the difference corresponding to the predetermined reference density, which is common among the plurality of halftone screening conditions, with each of the input density C_{in} (ranging from 0 to 255) of the cyan (C) image corresponding to the dot position X_{in} (ranging from 0 to 7000) in the main scanning direction of the third image forming unit **14**C.

Thus, the common difference table **34** is represented by a matrix including values, which represent differences of the number obtained by multiplying the number of gradation levels (256) by the number of dots (7000) in the main scanning direction of each of the image forming units **14**. Incidentally, the number of bits required to indicate the difference corresponding to one dot is several bits (for example, 4 bits) even when including a sign bit. Therefore, the capacity of the common difference storage portion **222**, which is necessary for storing the common difference table **34** corresponding to one of the colors C, M, Y, and K, is less than that capacity needed for storing the common density correction table **32** shown in FIG. **2**, regardless of the number of halftone screening conditions.

The correction coefficient table **36** associates the coefficient, which corresponds to the common difference table **34** used to correct the color unevenness difference corresponding to each of the halftone screening conditions, with the input density C_{in} of the image corresponding to each of the plurality of different halftone screening conditions. The screening condition A is that the number of screen lines is, for instance, 150. The screening condition B is that the number of screen lines is, for example, 600.

Thus, the condition dependent correction table **30** is represented by a matrix including the coefficients, the number of which is given by multiplying the number of gradation levels (256) by the number of halftone screening conditions, which can be printed by the image processing apparatus **10**. Incidentally, the number of bits needed to designate the coefficient corresponding to one dot is less than 8. Therefore, the capacity of the correction coefficient storage portion **224**, which is necessary for storing the correction coefficient table **36** corresponding to one of the colors C, M, Y, and K, varies according to the number of halftone screening conditions and can be made to be less than the capacity needed for storing the common density correction table **32** shown in FIG. **2**.

For example, in a case where the screening condition inputted to the multiplication portion **226** through the user interface (not shown) is the screening condition B (the number of screen lines is 600) and where the control portion **20'** obtains the input density C_{in} (the density value=120) corresponding to a dot, whose dot position X_{in} in the main scanning direction is 100, the multiplication portion **226** receives (+4) from the common difference table **34** as the difference value, and also receives a coefficient of 2.0 from the correction coefficient table **36** of the correction coefficient storage portion **224**. Then, the multiplication portion **226** calculates a correction amount of (+8) by multiplying the difference (+4) by the coefficient (2.0). Subsequently, the multiplication portion **226** outputs the correction amount to the addition portion **228**.

The addition portion **228** calculates the corrected density value 128 (=120+2.0×4) by receiving and adding the input density C_{in}, whose density value is 120, and the correction amount (+8). Then, the addition portion **228** outputs the corrected density value to the selector **206**.

FIG. **8** is a flowchart illustrating a process S**30** of the control portion **20'** that corrects color unevenness in an image obtained from the DFE according to the common difference table **34** and the correction coefficient table **36**.

As illustrated in FIG. **8**, in step **300** (S**300**), the common difference storage portion **222**, the correction coefficient storage portion **224**, and the addition portion **228** obtain image data (representing the input density in terms of the density value) corresponding to each of the colors C, M, Y, and K from the DFE.

For example, in a case where the screening condition inputted through the user interface (not shown) is the screening condition B (the number of screen lines is 600), the common difference storage portion **222**, the correction coefficient storage portion **224**, and the addition portion **228** obtain the input density C_{in}, whose density value is 120, corresponding to a dot whose dot position in the main scanning direction X_{in} is 100.

In step **302** (S**302**), the multiplication portion **226** receives the difference value from the common difference table **34** of the common difference storage portion **222**. For instance, the multiplication portion **226** receives a value of (+4) as the value of the difference, as illustrated in FIG. **7**.

In step **304** (S**304**), the multiplication portion **226** receives the correction coefficient table **36** of the correction coefficient storage portion **224**. For instance, the multiplication portion **226** receives a value of 20 as the coefficient, as illustrated in FIG. **7**.

In step **306** (S**306**), the multiplication portion **226** calculates a correction amount by multiplying the received difference value by the received coefficient. For example, the multiplication portion **226** calculates a value of +8 as the correction amount.

In step **308** (S**308**), the addition portion **228** receives the correction amount and then adds the received correction amount to the input density to thereby calculate the corrected density value. For instance, the addition portion **228** receives a value of +8 as the correction amount, as illustrated in FIG. **7**. Then, addition portion **228** adds the received correction amount to the input density C_{in}, whose density value is 120, to thereby calculate the corrected density value 128 (=120+2.0×4).

Incidentally, the tables (the common density correction table **32** and the common difference table **34**), which are common among the plurality of halftone screening conditions serving as the reference of color unevenness correction, may be set corresponding to the most frequently used screening condition. Alternatively, these tables may be set corresponding to the condition (for example, the largest number of screening lines), under which color unevenness occurs most frequently.

Further, the foregoing description of the embodiment has described the case where the patterns are formed so that the test images have the same density in the main scanning direction, thereby to correct color unevenness in the main scanning direction, by way of example. However, the patterns according to the invention are not limited thereto and may be formed so that the test images have the same density in the sub-scanning direction, thereby to correct color unevenness in the sub-scanning direction.

Additionally, the foregoing description of the embodiment has described the case where the image reading unit **11** reads a test image by setting the test image on the image reading unit **11** by a user, by way of example. However, the invention is not limited thereto. For example, the reading unit may be provided in the apparatus to read a test image after the test image is fixed on a recording medium. Further, after the test image is read, the recording medium may be discharged from the image processing apparatus **10**.

According to embodiments, the storage unit stores a correction amount corresponding to a density of an image. Therefore, even when the color unevenness varies according to the density of the image, the color unevenness can appropriately be corrected.

According to embodiments, the storage unit stores the correction amount by dividing information representing the correction amount into data representing a density correction table, which is common among the plurality of halftone screening conditions, and data representing a condition dependent correction table used to correct a color unevenness difference depending on the halftone screening conditions. That is, in a case where color unevenness is corrected according to the plurality of halftone screening conditions, the density correction table, which is common among the plurality of halftone screening conditions, can be shared. Thus, the capacity of a memory, which is needed for storing the table used to correct the color unevenness, can be reduced.

Also, it has been found that the frequency of occurrence of color unevenness in an image varies according to the halftone screening conditions and to the input density of the image, and that color unevenness frequently occurs at the substantially same position.

According to embodiments, the storage unit stores the correction amount by dividing data representing the correction amount into information representing a density correction table, which is common among the plurality of halftone screening conditions, and information representing a condition dependent correction table used to correct a color unevenness difference depending on the halftone screening conditions. Consequently, the difference table represents the density difference corresponding to the predetermined density. Thus, the number of bits needed for representing the density of one pixel (or dot) can be reduced. The capacity of a memory, which is necessary for storing the table used to correct the color unevenness, can be reduced.

According to embodiments, in a case where color unevenness is corrected according to a plurality of halftone screening conditions, the capacity of a memory used to store a table for correcting color unevenness can be reduced.

The foregoing description of the embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

The entire disclosure of Japanese Patent Application No. 2005-271783 filed on Sep. 20, 2005 including specification, claims, drawings and abstract is incorporated herein be reference in its entirety.

FIG. **1**

210 CORRECTION COMPUTING CIRCUIT (CPU)

208 IMAGE MEMORY

200 INPUT DENSITY CONVERSION PORTION
202 COMMON CORRECTION PORTION
206 SELECTOR
212 MEMORY
214 MEMORY
204 TEST IMAGE DATA GENERATING CIRCUIT
FIG. 3
S100 OBTAIN SCREENING CONDITIONS
S102 DETECT COLOR UNEVENNESS
S104 CALCULATE CORRECTION AMOUNT CORRESPONDING TO COLOR UNEVENNESS
S106 DECOMPOSE CORRECTION AMOUNT INFOPMATION
5108 STORE DECOMPOSED INFORMATION (CORRECTION AMOUNT INFORMATION)
S110 IS DECOMPOSED INFORMATION RESPECTIVELY CORRESPONDING TO ALL SCREENING CONDITIONS STORED?
FIG. 4
S200 OBTAIN INPUT DENSITY (DENSITY VALUE)
S202 CORRECT INPUT DENSITY (DENSITY VALUE)
S204 DENSITY CORRECTION
FIG. 5
220 CORRECTION COMPUTING CIRCUIT (CPU)
208 IMAGE MEMORY
224 CORRECTION COEFFICIENT STORAGE PORTION
222 COMMON (REFERENCE) DIFFERENCE STORAGE PORTION
226 MULTIPLICATION PORTION
228 ADDITION PORTION
206 SELECTOR
204 TEST IMAGE DATA GENERATING CIRCUIT
FIG. 8
S300 OBTAIN INPUT DENSITY (DENSITY VALUE)
3302 RECEIVE DIFFERENCE CORRESPONDING TO REFERENCE DENSITY
3304 RECEIVE CORRECTION COEFFICIENT
3306 CALCULATE CORRECTION AMOUNT
3308 ADD CORRECTION AMOUNT TO INPUT DENSITY (CORRECTION PROCESSING)

What is claimed is:

1. An image processing apparatus comprising:

a storage unit that stores a correction amount used to correct color unevenness of an image according to a plurality of halftone screening conditions; and

a correction unit that corrects an input image according to the correction amount stored in the storage unit;

wherein the stored correction amount comprises common information, which is common among the halftone screening conditions, and dependent information, which is dependent on the respective halftone screening conditions, and

wherein the common information corresponds to positions in a main scanning direction of the image processing apparatus.

2. The image processing apparatus according to claim 1,

wherein the storage unit stores the correction amount according to a density of an image.

3. The image processing apparatus according to claim 1,

wherein the storage unit stores a density correction table including the common information, and a condition dependent table including the dependent information used to correct color unevenness which is dependent on the respective halftone screening conditions.

4. The image processing apparatus according to claim 1,

wherein the storage unit stores a density difference table including the common information which represents each density difference between a corresponding predetermined density and a corresponding corrected density, and a coefficient table including the dependent information, which represents each coefficient for the corresponding density difference and is used to correct the color unevenness which is dependent on the respective halftone screening conditions.

5. An image processing apparatus comprising:

a detection unit that detects color unevenness of an image according to a plurality of halftone screening conditions;

a correction amount calculation unit that calculates a correction amount corresponding to the color unevenness detected by the detection unit;

a correction amount division unit that divides the correction amount into common information which is common among the halftone screening conditions, and a dependent information which is dependent on the respective halftone screening conditions;

a storage unit that stores the common information and the dependent information;

a correction unit that corrects the image according to the correction amount stored in the storage unit.

6. The image processing apparatus according to claim 5,

wherein the correction amount calculation unit calculates the correction amount according to a density of the image.

7. The image processing apparatus according to claim 5,

wherein the correction amount division unit divides the correction amount into a density correction table including common information and a condition dependent table including the dependent information used to correct color unevenness which is dependent on the respective halftone screening conditions.

8. The image processing apparatus according to claim 5,

wherein the correction amount division unit divides the correction amount into a density difference table including the common information which represents each density difference between a corresponding predetermined density and a corresponding corrected density, and a coefficient table including the dependent information, which represents each coefficient for the corresponding density difference and is used to correct the color unevenness which is dependent on the respective halftone screening conditions.

9. An image processing apparatus comprising:

a print unit that prints an image on a recording medium according to a plurality of halftone screening conditions;

a detection unit that detects color unevenness of the image printed by the print unit;

a correction amount calculation unit that calculates a correction amount corresponding to color unevenness detected by the detection unit;

a correction amount division unit that divides the correction amount calculated by the correction amount calculation unit into common information, which is common among the halftone screening conditions, and dependent information, which is dependent on the respective halftone screening conditions;

a storage unit that stores the common information and the dependent information; and

a control unit that controls the print unit to print the image based on the correction amount stored in the storage unit.

10. The image processing apparatus according to claim 9,

wherein the correction amount calculation unit calculates the correction amount according to a density of the image.

11. The image processing apparatus according to claim 9, wherein the correction amount division unit divides the correction amount into a density correction table including common information and a condition dependent table including the dependent information used to correct color unevenness which is dependent on the respective halftone screening conditions.

12. The image processing apparatus according to claim 9, wherein the correction amount division unit divides the correction amount into a density difference table including the common information which represents each density difference between a corresponding predetermined density and a corresponding corrected density, and a coefficient table including the dependent information, which represents each coefficient for the corresponding density difference and is used to correct the color unevenness which is dependent on the respective halftone screening conditions.

13. An image processing method comprising:

storing a correction amount used to correct color unevenness of an image according to a plurality of halftone screening conditions; and

correcting an input image according to the stored correction amount;

wherein the correction amount includes common information, which is common among the halftone screening conditions, and dependent information, which is dependent on the respective halftone screening conditions, and

wherein the stored correction amount includes a density difference table including common information which represents each density difference between a corresponding predetermined density and a corresponding corrected density, and a coefficient table including the dependent information, which represents each coefficient for the corresponding density difference and is used to correct the color unevenness which is dependent on the respective halftone screening conditions.

14. The image processing method according to claim 13, wherein the stored correction amount corresponds to a density of an image.

15. The image processing method according to claim 13, wherein the stored correction amount comprises a density correction table including common information and a condition dependent table including dependent information used to correct color unevenness which is dependent on the respective halftone screening conditions.

16. An image processing apparatus comprising:

a storage unit that stores a correction amount used to correct color unevenness of an image; and

a correction unit that corrects an input image according to the correction amounts stored in the storage unit;

wherein the correction amount comprises a density correction amount which is common among a plurality of halftone screening conditions, the density correction amount corresponding to positions in a main scanning direction, and a density correction amount which is not common among the plurality of the halftone screening conditions.

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